



UNIVERSITI PUTRA MALAYSIA

**ATTAINMENT OF DESIRED MAGNETIC PROPERTIES OF
Mg-Zn FERRITE BY CONTROLLING THE COMPOSITION
AND MICROSTRUCTURE**

TAN THIAN KHOON

FSAS 2000 15

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**MASTER OF SCIENCE
UNIVERSITI PUTRA MALAYSIA**

2000



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By

TAN THIAN KHOON

**Thesis Submitted in Fulfilment of the Requirements for the
Degree of Master of Science in the
Faculty of Science and Environmental Studies
Universiti Putra Malaysia**

August 2000

I would like to dedicate to:

**My Parents,
My Brother,
My Sisters,**

My Supervisor,

UPM Ferrites Research Group 99,

My Friends,

Everyone who involved in this study...

Abstract of the thesis presented to the Senate of Universiti Putra Malaysia
in fulfilment of requirements for the degree of Master of Science

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Chairman : Assoc. Prof. Dr. Mansor Hashim

Faculty : Science and Environmental Studies

This research work was conducted to investigate and understand better the characteristics of magnesium based ferrites. Magnesium-based ferrites were chosen due to one of their vital characteristics, that is high electrical resistivity, which can make them better materials at higher operating frequencies. Besides, they have a lower production cost and no environmental effect. Therefore, perhaps, they can be a better substitute to the existing technological ferrites and consequently replacing them. In order to achieve these goals, a wide-scope experimental investigation was conducted. The samples were prepared by the oxide ceramic processing method, involving dry mixing and solid state reactions. The experimental investigation covered the effects of compositional variations in magnesium-based ferrites with iron deficiency, excess zinc, iron deficiency with excess zinc, magnesium-zinc ion exchange and magnesium-iron ion exchange. Additional experimental work was also carried out to study the effects, on microstructure, of the grinding time, pre-sintering temperature, sintering temperature and sintering time. It was found that, in general, iron deficiency and excess zinc was beneficial to obtaining good magnetic properties. For the magnesium-zinc and magnesium-iron ion exchange, there existed particular compositions which yielded optimum magnetic properties. It was also learned

that sintering temperature and time were both very important in achieving the desired properties.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
bagi memenuhi keperluan untuk ijazah Master Sains

**KEDAPATAN SIFAT MAGNET YANG DIKEHENDAKI KE ATAS FERIT
Mg-Zn DENGAN KAWALAN KOMPOSISI DAN MIKROSTRUKTUR**

Oleh

TAN THIAN KHOON

Ogos 2000

Pengerusi : Prof. Madya. Dr. Mansor Hashim
Fakulti : Sains dan Pengajian Alam Sekitar

Penyelidikan ini dijalankan bagi mengenalpasti and memahami dengan lebih mendalam sifat-sifat ferit berasaskan magnesium. Ferit-ferit berasaskan magnesium dipilih disebabkan oleh salah satu daripada kelebihanannya, iaitu sifat kerintangan yang tinggi yang menjadikan bahan tersebut lebih baik pada frekuensi pengoperasian yang lebih tinggi. Di samping itu, mereka mempunyai kos penghasilan yang agak rendah serta tidak mempunyai kesan ke atas alam sekitar. Dengan demikian, adalah diharapkan mereka boleh menjadi pengganti yang lebih baik kepada teknologi ferit yang sedia ada dan seterusnya menggantikan mereka. Bagi mencapai matlamat tersebut, suatu kajian eksperimen meliputi suatu julat yang luas telah dijalankan. Sampel-sampel telah disediakan berdasarkan kaedah pemprosesan oksida seramik, melibatkan kaedah kering dan tindakbalas keadaan pepejal. Kajian eksperimen meliputi kesan terhadap perubahan komposisi di dalam ferit berasaskan magnesium dengan pengurangan bahan besi, lebihan bahan zink, pengurangan bahan besi berserta lebihan bahan zink, penukargantian antara ion magnesium-zink dan penukargantian antara ion magnesium-besi. Di samping itu, kerja eksperimen juga dijalankan bagi mengkaji kesan ke atas mikrostruktur, iaitu masa pemecahan bahan, suhu pra-pembakaran, suhu pembakaran dan julat masa pembakaran. Adalah didapati bahawa, umumnya, pengurangan bahan besi dan lebihan bahan zink amat berfaedah bagi mencapai sifat-sifat magnet yang baik.

Bagi penukargantian antara ion magnesium-zink dan magnesium-besi, didapati wujud tahap komposisi yang boleh mencapai sifat-sifat magnet yang optimum. Ia juga didapati bahawa suhu dan masa pembakaran adalah amat penting bagi mencapai sifat bahan yang diperlukan.

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I certify that an Examination Committee met on 14th August 2000 to conduct the final examination of Tan Tian Khoon on his Master of Science thesis entitled "Attainment of Desired Magnetic Properties of Mg-Zn Ferrite by Controlling the Composition and Microstructure" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.



Tan Thian Khoon,
28 Sept 2000.

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LIST OF SYMBOLS AND ABBREVIATIONS

H	applied field
μ_B	Bohr magneton
H_c	coercive force
A	cross sectional area
T_c	Curie temperature
ρ	density
f	frequency
B	induction
L	inductance
μ_i	initial permeability
D_i	inner diameter
σ	internal stress
l	length
$\tan \delta$	loss tangen
μ_0	permeability of free space
N	number of wire turns
D_o	outer diameter
PVA	poly-vinyl alcohol
T_{ps}	pre-sintering temperature
Q	quality factor
RLF	relative loss factor
B_r	remanent induction
R	resistance